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ABSTRACT

Due to the increasing demand on the United States to convert to the metric system of measurement, this document was developed to alert owner-managers to the implications surrounding the system as well as to increase their knowledge of it. Based on the findings of a 3-year Federal study, the information presented focuses on the possibility of the U. S. changing to the metric system and the expressed anxieties associated with such a conversion. Included is a plan for national changeover to the metric system over a 10-year period. (SN)

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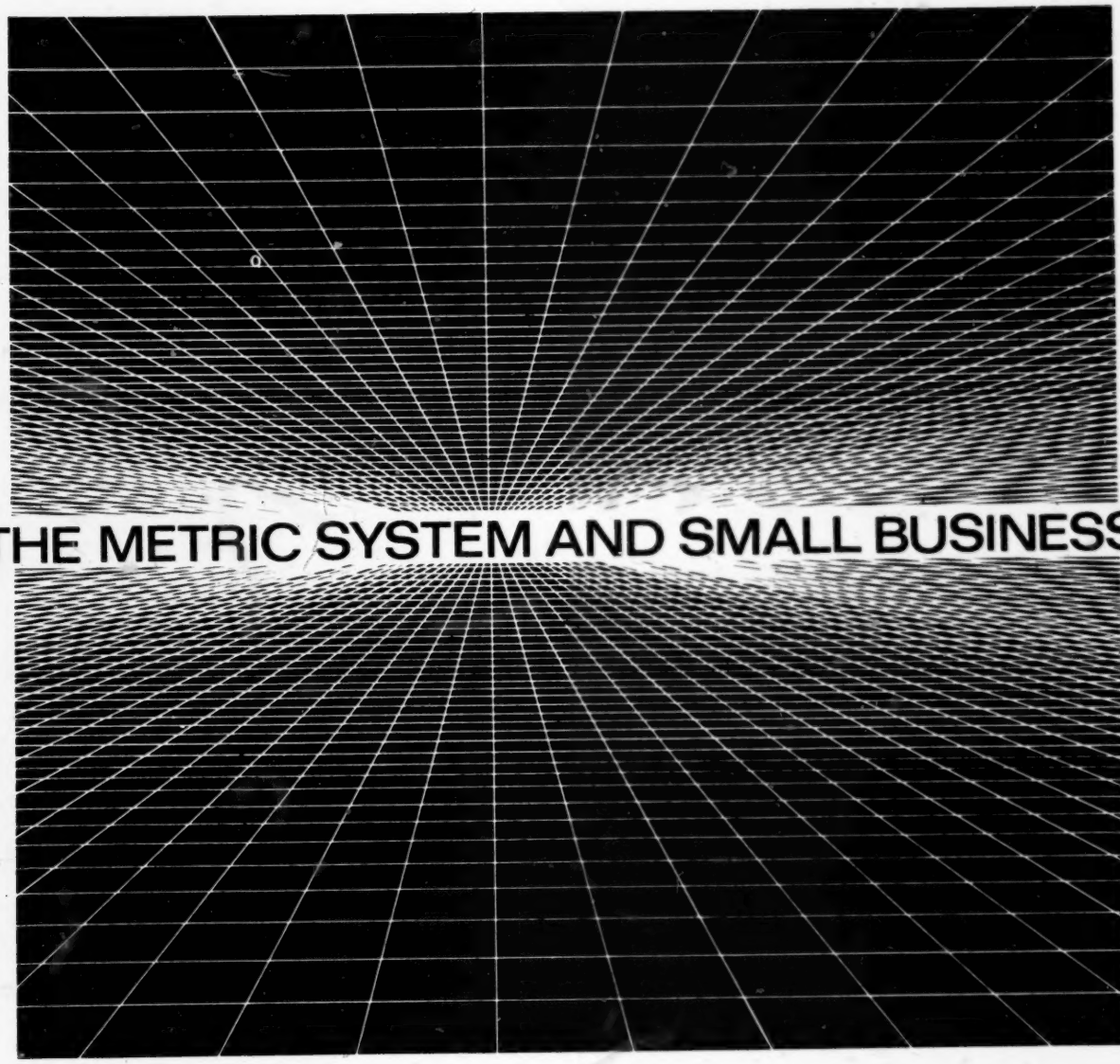

THE METRIC SYSTEM AND SMALL BUSINESS

VT 020318

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SUMMARY

From time to time, a *Management Aid* is published to suggest that owner-managers look to the future—to the horizon. Trends or techniques may be appearing that will demand your attention at a future date.

This *Aid* is such an article. It discusses the matter of the United States changing to the metric system of measurement. At the present time, this country is the only major nation not operating on it or committed to it.

The basic material used in developing this *Aid* is contained in *A Metric America—A Decision Whose Time Has Come*, which is a Report to the Congress on the findings of a 3-year study on the impact that the increasing worldwide use of the metric system has had on the United States.

A plan for national changeover to the metric system over a 10-year period has been recommended. This *Aid* discusses what led up to that recommendation and urges owner-managers to be alert to developments as the Nation considers this proposal through its Congress.

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Some owner-managers of small businesses have been thinking about the metric system and how it relates to their operation. Others haven't paid much attention to it. It is a subject that you should be considering. Briefly, what is involved is the question of America's increase in the use of the metric system of weights and measures—that is, a change from the customary language of inches and pounds to the metric language of meters and kilograms.

Why change? For many reasons, all of which stem from the fact that the United States is now the only major country in the world *not* committed to the metric system.

This situation has been studied in detail. Because the U.S. Congress has the responsibility to fix the national standards of weights and measures, it ordered a nationwide survey. A 3-year study was made of all major segments of American society to determine how the country as a whole felt about the matter. (*A Metric America—A Decision Whose Time Has Come.* See "For Further Information" on page11of this *Aid.*) The results of the survey show a clear consensus that:

1. Increased use of the metric system is in the best interests of the United States.
2. The Nation should change to the metric system through a cooordinated national program.
3. The transition period should be 10 years, at the end of which the Nation would be predominantly metric.

So the time has come for all Americans to start considering what this means in terms of their own lives. Obviously, it is especially important for owner-managers of small businesses to examine the situation.

How Our Customary System Grew

Most people don't think of a system of weights and measures as being a language. But it is. The words and symbols for length, mass, time, temperature, and so forth, allow individuals to communicate with one another in terms of quantity. This knowledge is so vital that it is often learned by people who learn nothing else, not even to read or write.

The customary system of measurement used today in the United States dates back to colonial days. In those times, measuring standards differed from country to country—in some places from town to town and even from trade to trade. There was great confusion and a jumble of poorly defined units.

The measuring standards we inherited from the British stemmed from a hodge-podge of Anglo-Saxon, Roman, and Norman weights and measures, based largely on folkways. For instance, early records indicate that an inch was originally defined as "three barleycorns, round and dry" when laid together, and a yard was roughly the length of a man's arm. But the English had started trying to set up certain uniform standards as far back as the 12th century. The yard of Henry II actually differs from the one we use today by only about one part in a thousand.

In his first message in 1790, President Washington told Congress that it was time for America to set its own standards of weights and measures. Secretary of State Thomas Jefferson submitted two plans, but in spite of prodding by the President neither was adopted.

About this time, the French statesman Tallyrand persuaded his government to adopt a new system of weights and measures. The result was the decimal-based "metric" system. It was based on a concept developed in 1670 by a vicar named Gabriel Mouton, in which the meter was defined as a specific fraction of the earth's circumference. The scheme was radically different from any of the commonly used measurement methods of that day. This metric system was wholly rational, quite simple, and internally consistent. It is the system that most of the world—including Great Britain and the Commonwealth Countries—has come to recognize and adopt.

While France, and then other nations, adopted the metric system, the debate about standards continued in the United States. It has been going on for almost 200 years. In 1816, President Madison reminded Congress that the lack of uniformity in weights and measures was a piece of unfinished business. Following this, in 1821, John Quincy Adams submitted a comprehensive report on the desirability of the metric system. But again no action was taken. Then, in 1866, Congress passed an act making lawful the use of metric in the United States. But still no move was made toward a national changeover. Nevertheless, ever since 1893, our customary fundamental standards of length and mass have been defined as fractions of metric units, the meter and the kilogram, respectively. (For example, an inch is officially 25.4 millimeters.)

The most important influence on the American debate has been the spread of the metric system throughout the world. By 1921, when Japan began converting to it, the metric system had been adopted by about half of the countries of the world. Practically all of the other nonmetric countries have since followed suit. England announced in 1965 that it would change over. In January of 1970, Canada and Australia announced that they would, too. Now over 90 percent of the world population lives in nations that are metric or committed to the metric system.

Actually, the metric system is more extensively used in the United States than most people realize. Doctors, druggists, and scientists use it for virtually all their measurements. In 1957, the year of the launching of Sputnik, the U.S. Army adopted it for its weaponry. Then in 1970 the National Aeronautics and Space Administration became the first Federal agency to adopt the system. Metric measurements and practices have been increasingly used in certain manufacturing industries.

The Logical Metric System

Today the metric system is known as the SI system (for Systéme International d' Unités). It is simpler than any other scheme of measurement that has been used. There are only seven base units for different types of measurement.

The unit of *length* is meter.
The unit of *mass* is kilogram.
The unit of *temperature* is kelvin.
The unit of *time* is second.
The unit of *electric current* is ampere.
The unit of *light intensity* is candela.
The unit of *amount of substance* is mole.

All other SI units are derived from these seven. For example, a newton, the unit of *force*, involves meters, kilograms, and seconds. A pascal, the unit of *pressure*, is one newton per square meter. And so on. Although the metric system was designed to fill all the needs of scientists and engineers, laymen need only know and use a few simple parts of it.

SI is based on the decimal system and follows a consistent name scheme. This makes for easier and more accurate calculation. Multiples and submultiples are always related to powers of 10.

Deka means ten times, hecto means a hundred, kilo means a thousand times, mega means a million times, and so on.

Deci means a tenth of, centi means a hundredth of, milli means a thousandth of, micro means a millionth of, and so on.

It is plain to see that SI is easier to learn than the customary system. Schools could well use the time now spent in teaching customary—with all the fractions and complicated calculations—for other new subjects. (Four of the SI base units are already used in our customary system—second, ampere, candela, and mole). Also, because metric is easier to use, it saves times and errors. Computations are much simpler. There is only one unit for each quantity and the relationship between the units is simple.

Naturally, if they use a common measurement language, scientists, engineers, businessmen, educators, and government officials throughout the world can communicate more freely and with less misunderstanding.

Advantages for America

The American economy today depends as never before on trading raw materials, manufactured products, and technological ideas with countries abroad, all of whom use or are changing to metric. Though small in relation to the total economy, our exports are crucial to maintaining a favorable trade balance in an increasingly metric world. The United States puts itself at a disadvantage competitively by using a measurement system that is different from that of the world market.

U.S. companies that want to make metric products, usually for sale abroad, have found it advantageous to build where they employ native workers who know the metric system. Such export of jobs is a problem that a national changeover to the metric system would help to halt.

America's military allies are either already using the metric system or committed to becoming metric. Therefore, military coordination and logistics would be simplified by conversion to metric. Use of SI would make all U.S. and foreign military equipment more compatible.

Moreover, if the United States is part of a common system, there should be one less hangup in relations with other nations.

And the fewer obstacles the better when it comes to setting international standards of all sorts especially those concerned with industrial products. Going metric should help this country win acceptance for its ideas.

That last point was particularly emphasized in the recommendations resulting from the national metric study. "Standards" refer not only to units of weight and measurement but also to product performance, quality control, applications, and so on. Engineering standards serve a technical society as both a dictionary and a recipe book. They specify characteristics of things or ways to do things—almost anything that can be measured or described.

Standards cover an enormous range. For example, the diameter of wire, the purity of aspirin, the meat content of frankfurters, the symbols on highway signs, the fire resistance of clothing, the wattage of light bulbs, the weight of a nickel, and the way to test for sulphur in fuel oil—to name but a few.

The Department of Defense and the General Services Administration have issued for Government use about 40,000 procurement standards. Hundreds of private, voluntary groups have issued about 20,000 (one-fifth of which are recognized as national standards).

Where U.S. standards differ from international standards, trade can be hindered. To date, relatively few international standards, 1,500 or so, have been adopted, but the number is expected to increase tenfold within the next 10 years. It is in the best interests of the United States to get in on the ground floor in the setting up of new international standards because such standards form the basis for international trade. Already, multinational corporations are tending to integrate the world economy and are helping to

Text Continued on Page 8

THESE PREFIXES MAY BE APPLIED TO ALL SI UNITS

Multiples and submultiples	Prefixes	Symbols
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
*1 000 000 = 10^{6}	mega	M
*1000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10	deka	da
0.1 = 10^{-1}	deci	d
*0.01 = 10^{-2}	centi	c
*0.001 = 10^{-3}	milli	m
*0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

*Most commonly used

Comparing the Commonest Measurement Units

Approximate conversions from customary to metric and vice versa.

	When you know:	You can find:	If you multiply by:
LENGTH	inches	millimeters	25
	feet	centimeters	30
	yards	meters	0.9
	miles	kilometers	1.6
	millimeters	inches	0.04
	centimeters	inches	0.4
	meters	yards	1.1
	kilometers	miles	0.6
AREA	square inches	square centimeters	6.5
	square feet	square meters	0.09
	square yards	square meters	0.8
	square miles	square kilometers	2.6
	acres	square hectometers (hectares)	0.4
	square centimeters	square inches	0.16
	square meters	square yards	1.2
	square kilometers	square miles	0.4
	square hectometers (hectares)	acres	2.5
MASS	ounces	grams	28
	pounds	kilograms	0.45
	short tons	megagrams (metric tons)	0.9
	grams	ounces	0.035
	kilograms	pounds	2.2
	megagrams (metric tons)	short tons	1.1
LIQUID VOLUME	ounces	milliliters	30
	pints	liters	0.47
	quarts	liters	0.95
	gallons	liters	3.8
	milliliters	ounces	0.034
	liters	pints	2.1
	liters	quarts	1.06
	liters	gallons	0.26
TEMPERATURE	degrees Fahrenheit	degrees Celsius	5/9 (after subtracting 32)
	degrees Celsius	degrees Fahrenheit	9/5 (then add 32)

bring about worldwide uniformity of engineering standards. In a metric world it is evident that these uniform international engineering standards will predominantly use metric weights and measures.

To sum up the advantages, a metric America would seem desirable in terms of the Nation's stake in world trade, its national security, its relations with its neighbors, and its participation in the development of international standards.

The U.S. Metric Study

In 1968, Congress authorized the Department of Commerce

> **. . . to conduct a program of investigation, research, and survey to determine the impact of increasing worldwide use of the metric system on the United States; to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States; to study the feasibility of retaining and promoting international use of dimensional and other engineering standards based on the customary measurement units of the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible for the United States.**

In the course of the U.S. metric study, opinions were gathered from many different cross sections of American life. On a national scale, whole industries were asked for their collective views. At the grass roots level, individual citizens expressed their personal thoughts in correspondence and in public hearings. And in between, ideas were collected from large and small firms, labor unions, professional and technical societies, and other groups with special interests. Participants included representatives of both manufacturing and nonmanufacturing industries.

In the manufacturing segment of the economy, questionnaires were sent to about 4,000 companies—a sample from the approximately 300,000 manufacturing companies in the United States. These companies ranged from tiny operations employing only a handful of people to giants with payrolls of tens of thousands. Asked whether increasing the use of metric would be good for the Nation as a whole, a large majority voted yes. More than 90 percent of those who responded preferred a coordinated national program based on either voluntary participation or mandatory legislation. Large manufacturing firms tended to be more in favor than small ones. However, some small manufacturers were among the most outspoken advocates of a metric changeover through a national program. Approximately 82 percent of the companies thought the transition period should be 10 years or less.

Of the nonmanufacturing businesses, again a substantial majority felt that increasing metric usage would be in the Nation's best interests. Eighty-six percent favored a national conversion program. And, speaking for themselves, the nonmanufacturing firms thought about 5 years or less would be sufficient for the changeover.

During the 3-year study, conferences were held by the National Bureau of Standards to afford all sectors of the Nation an opportunity to express their views. The consensus was that a changeover to metric is inevitable, that the costs and inconveniences of conversion will never be less than they are now, and that the need will be ever more increasing.

Before the study many courses of action were deemed to be conceivable, including an abrupt and mandatory conversion to metric on the one hand and a program to promote more use of customary on the other hand. From the study it develops that the feasible courses of action are narrowed to two main alternatives:

1. To allow the increase of use of the metric system in the United States to continue to accelerate without overall design, or
2. To adopt the measurement system that has achieved worldwide acceptance and to work out a plan for changing to it.

The main purpose of a planned program is to minimize breakdowns in cooperation and coordination during a changeover. In a planned program, metric parts can be available when needed, metric products will be in demand when they are made, and employees can be appropriately trained on a "when and as needed" basis.

Unfortunately, the study could not produce a balance sheet of costs and benefits incident to changing to metric. It is plain that benefits and costs are not directly comparable because they would occur at different times. Virtually all costs would be incurred during the transition. The benefits, some of which are intangible, would not appear until afterward. In addition, metrication costs are almost impossible to evaluate because they cannot be isolated from the usual and normal costs of innovation and redesign. It is at the time of redesign that metric can be most economically introduced.

Experience in Britain shows that conversion turns out to be much easier and less costly than anticipated. The British are following a policy of "letting the costs lie where they fall." Metrication is being coordinated by a small group known as the Metrication Board at a very modest cost to the taxpayer. The general rule is that everybody in the society, including governmental agencies, must share in the temporary costs just as they will share in the continuing benefits. The same philosophy was followed by Japan in its conversion to metric.

The U.S. metric study report points out that such a general policy "does not exclude special assistance for small business. Nor does it exclude some help during the transition period in the form of accelerated depreciation for machinery and investment tax credits. Even under the present tax laws, metric conversion costs would be tax deductible."

The costs and inconveniences of metric conversion are temporary. They stop at the end of the transition period, while the benefits continue indefinitely.

Congressional Concern

As the owner-manager of a small business, you probably are wondering what happens to small business in a national metric changeover. And rightly so. Already Congress has been looking into the matter.

The Select Committee on Small Business of the House of Representatives assigned to its Subcommittee on Minority Small Business Enterprise the task of conducting hearings. The objective was

> **. . . to identify not only those small business problems which may arise from a national transition, but also the difficulties which small business may face as a result of an increased use of metric weights and measures by their large business competitors . . . [and] review methods by which the Federal agencies and departments may provide the assistance necessary to preserve the competitive position of small business in our economy.**

Based on those hearings and the nationwide metric study, the Subcommittee submitted a report on March 14, 1972, on "Small Business Problems in Metric Conversion." (See "For Further Information" on page 11 of this *Aid*.) The problem of education is considered the most basic one. The primary task that faces the small businessman—whether he be manufacturer,

merchant, or distributor—is to learn to "think metric" and understand the system sufficiently to plan for transition on an orderly and sound basis. The report points out that because small businesses appear to use the metric system to a lesser degree, they will encounter more difficulty in changing to metric meaures than larger businesses, which tend to set the pace.

The report expresses the Subcommittee's concern that all appropriate governmental agencies should cooperate in aiding and assisting the small business sector and that timely steps should be initiated to assure that small business will continue to be a viable part of American enterprise and a competitive factor in both the domestic and foreign markets.

Along with other recommendations regarding the activities of large business and Government in relation to small business during metrication, the Subcommittee recommended "that the appropriate legislative committees of the Congress consider legislation which would amend the Small Business Act to provide financial assistance to small business concerns in converting to the metric system" and "that the Select Committee on Small Business of the House of Representatives continue to study the impact of metrication upon small business, in the light of actual ongoing experience."

Getting Started

Many owner-managers of small businesses may be like the general public which, according to the U.S. metric study, knows little about the metric system. In fact, only 40 percent of the individuals sampled could name a single metric unit. And only half of those were familiar with relationships among customary and metric units.

As the British found out, mass education is needed. In the process of their changeover, the British Metrication Board is using newspapers, magazines, radio, television, and other media to inform the people about the metric units they are likely to encounter in everyday living—trusting them to pick up on their own any more technical details they may desire to know.

"Soft change" is the term used when referring to the switchover from one language of measurement to another—without changing the design of the product—for example, labeling the contents of a container in grams rather than ounces or specifying the dimensions of our very complicated splines in millimeters instead of inches, as has already been done by our Society of Automotive Engineers. The term "hard change" refers to altering sizes, weights, and other dimensions of physical objects—for example, packaging milk in a liter instead of a quart container or designing roller bearings in millimeter modules rather than inch modules. Small business will be concerned in varying degrees with both types of changes.

Increased use of the metric system is becoming more and more common in industry. A similar situation exists in our educational system. It is likely that before long the metric system of weights and measures will be taught in every school in the United States. Government assistance may be needed to help develop teacher training, plans, and materials.

If this article has started you thinking of problems that may arise in your own business when you try to use the metric system, the reading has been worth your time. It is always better to anticipate problems than to be caught unaware by them. Regarding America's conversion to metric, what should you do about it now? The main thing is to keep informed about its status. Be alert for news items about it. Look for articles in your trade journals that discuss the matter as it relates to your line of business. Of most importance, stay current with respect to the status of those engineering standards, if any,

that are pertinent to your business and participate either directly or through an association that represents you in planning the changeover of these standards to metric.

In summary, treat this subject as you would any management problem. Gather all the pertinent facts. Find out now what your industry is doing, or plans to do, about the metric system. Look for alternatives that may be open to you. Determine your costs. Then make the judgment that seems best for your business.

For Further Information

A Metric America. National Bureau of Standards Special Publication 345 (1971). Available for $2.25 from Superintendent of Documents, Washington, D.C. 20402. (Order by SD Catalog No. C 13.10:345)

Small Business Problems in Metric Conversion, House Report No. 92-913, U.S. Government Printing Office, Washington (1972).

ASTM Metric Practice Guide, American National Standard Z210.1. Available for $1.50 from American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

Understanding the Metric System by David M. Miller (1965). Paperbound programmed learning book, 343 frames. Available for $1.32 from Allyn and Bacon, Inc., 470 Atlantic Ave., Boston, Mass. 02210.

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